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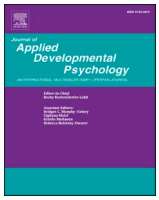

Teacher mindset is associated with development of students' growth mindset☆

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ABSTRACT

Are teachers' growth mindsets associated with the development of growth mindsets in their students? We know that teacher growth mindset (TGM) shapes the attributions teachers make about their students' abilities and can lead to assumptions about the role that perceived stable traits play in students' performance; however, to date, research has not focused on the relationship between TGM and the development of student growth mindset. This study fills a gap in our knowledge by testing this association over time. Findings from an analytic sample of 57 teachers and 1957 intervention students reveal that teachers with growth mindsets have a mild positive and statistically significant association with the development of their students' growth mindsets, particularly for boys. Implications for teacher education, practice, and future research are discussed.

Introduction

Mindset theory (Dweck, Chiu, & Hong, 1995; Dweck & Leggett, 1988) proposes that individuals hold mindsets ranging from fixed, wherein intelligence is viewed as stable and unchangeable, to growth, wherein intelligence is seen as malleable (Dweck, 1999; Dweck & Grant, 2008). The extent to which students hold growth (vs. fixed) mindsets plays a role in their academic achievements (Blackwell, Trzesniewski, & Dweck, 2007; Rattan, Savani, Chugh, & Dweck, 2015; see also Aronson, Fried, & Good, 2002), as well as their successes later in life in areas such as financial management (Abernethy, Anderson, Nair, & Jiang, 2021) and career progression (Caniëls, Semeijn, & Renders, 2018; Visser, 2013). Growth mindsets are generally believed to have positive effects on motivation and resilience in the face of failure, whereas fixed mindsets are believed to diminish motivation and, in turn, impair performance (Carr & Dweck, 2011).

Interest in the concept of growth mindset, also termed implicit theories of intelligence, began to increase following the release of Dweck's (2006) book, *Mindset: The New Psychology of Success*; however, much of the focus has been on mindset as an intra-individual characteristic, absent of context. Within education, students' growth mindsets have been mildly associated with individual outcomes irrespective of where and around whom the students interact or how the mindsets themselves developed. For example, Sisk, Burgoyne, Sun, Butler, and McNamara (2018) found in a meta-analysis ($k = 273$; $N = 365{,}915$) that implicit theories of intelligence can influence the academic outcomes of students. They go on to argue that students with low socioeconomic status, and/or those who are most academically at risk, are most likely to benefit from mindset interventions. Given the dynamic nature of teacher-learner interactions, a natural next step for the field was to inquire into what contextual factors support or inhibit students' development of growth mindsets.

To date, most research on mindset has focused on the student directly, underexploring the possible effects that peers or mentors may have on mindset development (Dweck, 2007; Dweck, Davidson, Nelson, & Enna, 1978; Good, Rattan, & Dweck, 2012; Haimovitz & Dweck, 2016; Rattan et al., 2015; Sisk et al., 2018). Interestingly, research has found that messages conveyed by teachers affect their students' academic performance (Dweck et al., 1978; Jampol & Zayas, 2020; Pishghadam, Naji Meidani, & Khajavy, 2015), which may be particularly

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important during transitions, such as from elementary to middle, or primary to secondary education (Evans, Borriello, & Field, 2018; Spernes, 2020). Given this awareness of teachers' potential impact on their pupils, and considering the amount of time that students spend with their teachers, this study seeks to examine the association between teacher mindset and the development of student mindset. Specifically, we ask: is teacher mindset associated with the development of students' mindsets in emergent to early adolescence?

In this paper, we first present the theoretical grounding of our investigation and build a conceptual framework for understanding this phenomenon. Next, we outline our study and detail results that address the identified gap in our knowledge. Finally, we present implications for teacher preparation programs and professional learning, concluding with a call for more research to investigate the relationship between teacher and student mindsets, with robust suggestions for future research.

Theoretical perspectives on the development of students' growth mindsets in educational contexts

Implicit theories of intelligence have emerged as persuasive psychological characteristics that are associated with students' success in school (Blackwell et al., 2007) and other outcomes such as school engagement and psychological well-being (Zeng, Hou, & Peng, 2016; Zhao et al., 2018). In 1988, Dweck and Leggett posited that implicit theories underlie goal-orientations (mastery through effort versus performance), which are linked to adaptive (e.g., challenge-seeking) or maladaptive (e.g., challenge-avoidant) behaviors that have since been found to influence students' learning and achievement over time (Kennett & Keefer, 2006; Schenke, Lam, Conley, & Karabenick, 2015; Stipek, Newton, & Chudgar, 2010). Although recent research has cast some doubt on the robustness of implicit theories' influence on academic outcomes (Burgoyne, Hambrick, & Macnamara, 2020; Burnette, O'Boyle, VanEpps, Pollack, & Finkel, 2013; Li & Bates, 2019), with boundary conditions also being identified (e.g., Sisk et al., 2018; see also Dweck & Yeager, 2019), implicit theories of intelligence present a useful framework for understanding intra-individual psychological processes related to students' various academic experiences.

We propose that there is an interplay between context and emergent-early adolescent students that shapes these implicit theories' development. Emergent and early adolescence is a critical period to consider in the development of growth mindset. Compared to younger students, emergent and early adolescents have more highly developed cognitive skills (Eccles & Wigfield, 1997). This allows them to process complex social information from ecological assets like teachers (Gestsdottir, Urban, Bowers, & Lerner, 2011) and integrate it into their rapidly developing identities (Meeus, Iedema, Helsen, & Vollebergh, 1999). Indeed, teachers continue to exert influence on students' academic, social, and behavioral development throughout late elementary and middle school (Roorda, Jak, Zee, Oort, & Koomen, 2017; Wang, Brinkworth, & Eccles, 2013), which highlights the importance of education contexts, and teachers specifically, on emergent and early adolescent development (Eccles & Roeser, 2012).

Supplemental theories suggest that the proximal context in which students' psychology develops and unfolds is paramount to the developmental process (Pianta, Hamre, & Stuhlman, 2003; Ryan & Deci, 2000). In particular, the concept that teachers and their beliefs (which inform their behavior and interactions with students) are influential in students' development (Archambault, Janosz, & Chouinard, 2012; Rattan, Good, & Dweck, 2012) is aligned with developmental systems theory (DST). DST postulates that characteristics of teachers and students define how an interaction will unfold and be perceived, thereby setting expectations for future interactions that ultimately influence students' development (Pianta et al., 2003). Similarly, ecological systems theory (EST; Woodside, Caldwell, & Spurr, 2006; Bronfenbrenner, 1979) would cast teachers as ecological assets (Futch Ehrlich, Deutsch, Fox, Johnson, & Varga, 2016; Gestsdottir et al., 2011) within the learning context who provide meaningful inputs in students' lives, and, in turn, influence their development; in this case, we argue that this applies to mindset development in particular. With this in mind, the present study leverages the intra-individual theory of motivation (Dweck & Leggett, 1988) coupled with DST and EST to inform an investigation of the association between teachers' growth mindsets and changes in 4th–8th grade students' growth mindsets over an academic year.

Growth mindset in the classroom

Students' mindset

Students' mindsets help shape the goals that students set for themselves, as well as how they self-evaluate throughout the work process. For example, students with a fixed mindset often pursue *performance* goals and regard achievements and outcomes (as opposed to effort and inputs) as indications of their competence. In so doing, they may foster maladaptive learning patterns by attempting to decrease their potential for failure and, consequently, avoiding opportunities for growth (Dweck, 2006; Dweck & Elliot, 1983; Dweck & Leggett, 1988). These students can be more likely to ascribe their successful performances to natural ability or intelligence and to give up when confronted with setbacks.

Conversely, students with a growth mindset often consider *learning* goals as a means of increasing competence, and are more likely to acquire adaptive learning patterns as they are challenged by failure (Dweck & Leggett, 1988; Lee, 1996). For these students, the possibility of failure can be seen as an opportunity to grow and improve, and failure itself can be seen as evidence of learning (as opposed to evidence of incompetence). Such students tend to attribute their successful performances to effort, focusing on the processes of their work and opportunities for learning and improvement (Blackwell et al., 2007; Dweck, 1999; Dweck & Leggett, 1988; Heine et al., 2001).

Beyond direct academic outcomes, mindset has been shown to influence other success-adjacent constructs in adolescent students' lives. For example, Schleider and Weisz (2017) found that a mindset intervention yielded a significant improvement in parent- and youth-reported depression and youth-reported anxiety and behavioral control. Similarly, Zeng et al. (2016) found that a mindset intervention in emergent and early adolescents improved psychological well-being and school engagement through the enhancement of resilience. As school gets more difficult (and especially during major transitions, such as the move from primary school to junior high), students' mindsets influence whether students perceive their struggles as evidence of their own incompetence (fixed mindset) or their maturation (growth mindset), and can shape various aspects of their school experience (Rege et al., 2020; Yeager et al., 2019).

Why teachers' mindsets may influence students' mindsets

Teachers with fixed mindsets attribute students' achievements to innate intelligence, whereas those with growth mindsets are more likely to perceive students' achievements as opportunities to further improve their competence (Dweck & Leggett, 1988). Research also shows that teachers with fixed mindsets tend to diagnose students' behavior as reflective of stable traits based on their previous performance. By contrast, teachers with growth mindsets are inclined to observe students' performance over time (Butler, 2000; Heslin, Latham, & VandeWalle, 2005; Plaks, Stroessner, Dweck, & Sherman, 2001). These teacher attributions could in turn influence how teachers treat students (de Kraker-Pauw, van Wesel, Krabbendam, & van Atteveldt, 2017; Georgiou, Christou, Stavrinides, & Panaoura, 2002; McGrath & van Bergen, 2019; Murdock-Perriera & Sedlacek, 2018), and, in so doing, shape the students' mindsets themselves.

For example, Rattan et al. (2012) predicted that comfort-oriented feedback (e.g., “It's OK not to be good at math”) would direct students

to perceive their teachers as employing a fixed attitude towards their math ability and, in turn, demotivate them. They compared comfort-oriented feedback to strategy-oriented feedback (stressing concrete learning strategies), finding that students who received comfort feedback did indeed perceive their teachers as possessing a conspicuously stronger fixed mindset, leading students to project lower expectations for themselves compared to those who received strategy-oriented or control feedback. Additionally, de Kraker-Pauw et al. (2017) found that teacher mindset influenced the amount and type of feedback they provided to students. In sum, students develop in context, and the practices of their teachers provide part of that context in the classroom.

Thus, in line with DST and EST, we propose that students' perceptions of teachers' mindset is significantly associated with students' expectations for their own success. However, prior research in this domain has typically focused on teachers' growth mindset *practices*, not their growth mindset *beliefs*. Thus, it remains less clear whether or not teachers' mindset per se is associated with the development of, or changes in, students' mindset throughout the academic year. Because teacher characteristics ultimately influence students' development (Pianta et al., 2003), mindsets have been shown to be malleable in response to environmental inputs (Blackwell et al., 2007; Paunesku et al., 2015; see also Woodside et al., 2006; Bronfenbrenner, 1979). Moreover, because early adolescence is characterized by an active state of self-concept development (Marsh et al., 2018), it seems probable that students' developing growth mindset may change with the influence of their teacher's (i.e., teachers serve as an ecological asset; Futch Ehrlich et al., 2016; Gestsdottir et al., 2011). As such, we hypothesize that high (vs. low) growth mindsets in teachers will be associated with positive (vs. negative) development of student growth mindset over time.

Additionally, teacher growth mindset practices have been shown to influence the development and retention of girls in at-risk situations (e.g., STEM; Good et al., 2012), which suggests that girls may be particularly susceptible to their teachers' mindsets. On the other hand, boys on average have poorer inhibitory control and higher incidence of externalizing than girls (Else-Quest, Hyde, Goldsmith, & van Hulle, 2006; Matthews, Ponitz, & Morrison, 2009), which may explain why Dweck et al. (1978) found that teachers are far more critical of boys than of girls (e.g., because their behavior may on average call for more direct correction in the classroom). Thus, boys may experience more evidence of their teacher's true beliefs about their abilities than do girls. Given the relevance of gender to both mindset and achievement (e.g., a gender gap in educational outcomes appears to be widening; Buchmann & DiPrete, 2006; Duckworth & Seligman, 2006; Fortin, Oreopoulos, & Phipps, 2015; O'Dea, Lagisz, Jennions, & Nakagawa, 2018; Voyer & Voyer, 2014), we incorporated gender as an exploratory moderator of our focal effect.

Present study

Through a review of the literature, we identified a gap in the knowledge on factors that are associated with students' growth or fixed mindset development in the classroom. To investigate the association between teacher and student mindsets, we examined how teacher growth mindset (TGM) is or is not associated with the development of student growth mindset (SGM) by investigating teachers and their students over the course of a school year. We further took an interest in exploring whether gender moderates our theorized relationship between TGM and SGM. In doing so, we present initial evidence addressing a gap in the literature, generating knowledge with implications for teacher preparation programs and for school district leaders to make more informed decisions concerning teacher selection and professional development in practice.

Method

Design

Our design employed a pretest-posttest design using web-based surveys. Teachers and students completed a survey at the beginning of the school year, and students completed a posttest survey at the end of the school year. This data is used to assess the association between TGM (assessed at the beginning of the school year) and SGM at the end of the year (after pretest SGM is statistically accounted for).

Data and participants

Data was collected through an international education non-profit which focuses on classrooms in low socioeconomic and/or remote rural areas.[1] Survey data were composed of teachers and their students from classrooms in grades 3–10 across the USA, Canada, and Germany. Data for this study comes from the 2017–2018 implementation of a social-emotional learning (SEL) intervention; all respondents were participants in the intervention. This intervention is aimed at increasing students' social-emotional skills by pairing classrooms with mentors who provide student mentoring and help teachers integrate an SEL curriculum. Data were collected in early fall (time 1; prior to implementation) and late spring (time 2; after implementation) of the academic year.

The total sample included 4750 students taught by 152 teachers. Observations were restricted to grades 4–8 ($N = 4599$) both to enable our focus on emergent and early adolescence and because the intervention focused on this age range, resulting in limited data from students in other grades. Similarly, students from Germany were excluded due to their low numbers ($N = 78$). Finally, because of full information maximum likelihood (FIML), the methodological approach taken to account for missing data (see Analytic Plan), is unable to accurately impute for dichotomous variables, respondents with missing data on such variables (e.g., students or teachers who did not report gender, grade-level; $N = 2564$)[2] were list-wise deleted in analyses. For non-dichotomous and continuous variables, FIML has been shown to yield less biased parameter estimates and less sampling variability compared to listwise deletion and mean imputation (Enders, 2001), which afforded us a robust method to retain cases with missing data only on continuous measures of interest (e.g., student growth mindset). Thus, the total analytic sample for the current study included 57 teachers and 1957 intervention students. Sixty percent of students were from the USA and 40% were from Canada. The plurality of students was in grade 5 (41.5%) with the remaining students in grade 4 (13%), grade 6 (26.5%), grade 7 (10%), and grade 8 (9%). Approximately 49% of the students were female. Teachers were majority female (92%) and reported an average of 15.5 years of teaching experience (SD = 7.58).

Procedures

Participants were recruited through the SEL program in which they were students (or teachers). Teachers received an email at the beginning of the school year prior to program implementation, inviting them to participate in the research. Those teachers with students in grade 4 or above were also asked to have their students participate and were

[1] The non-profit provided services to only Title 1 schools during this implementation, suggesting that the sample is comprised of a high percentage of children from low-income families. No standardized socioeconomic data is available in Canada, where no similar standard exists.

[2] To ensure significant associations were not due to complete missing data at one time point, a sensitivity analysis was conducted restricting the sample to only those participants for whom both pre- and post-intervention data were observed ($N_{total} = 1{,}149$, $N_{analytic} = 755$). Trends in significant associations did not differ from those presented using all available data.

provided with consent forms to distribute to parents. Once parental consent was obtained, teachers provided the electronic survey to students via computer either in a computer lab as a group, or one at a time on an in-class computer, until all students had participated. Teachers also completed their survey online, prefaced with informed consent, prior to implementation. At the end of the school year, students once again completed an online survey administered by the teacher. In all cases, the focal items were embedded within a variety of other measures of interest to the non-profit organization.

Measures

Student growth mindset (SGM)

Four items were used to assess the extent to which students believed their intelligence to be a fixed trait (see Appendix for a complete list of items; Farrington, Levenstein, & Nagaoka, 2013). This growth mindset scale was prioritized for data collection because it had been widely implemented by California CORE districts (Meyer, Wang, & Rice, 2018). Students responded to items using a 5-point Likert scale ranging from *Not at all true* to *Completely true*. Items were reverse-coded such that higher scores indicated growth mindset and lower scores indicated fixed mindset. These items showed low but acceptable internal consistency across grades at time 1 ($\alpha = 0.70$) and time 2 ($\alpha = 0.71$; Cohen, 1988; see Appendix).[3] These estimates are in line with those found for the same measure of growth mindset in prior research (Gehlbach & Hough, 2018).

Given the low alphas, particularly for certain grades (see Appendix), a series of confirmatory factor analyses (CFA) were examined. The CFA across grades shows good fit at time 1 (CFI = 0.998, TLI = 0.99, RMSEA = 0.02) and acceptable at time 2 (CFI = 1.00, TLI = 1.00, RMSEA = 0.00), with all items contributing appreciable variance to the latent factor (factor loadings ranged from 0.55–0.68). With evidence that the same underlying construct was being measured across all grades, we proceeded using the mean score so as to produce results interpretable on the original response scale. As a robustness check, however, models were also estimated including fall and spring student growth mindset as a latent construct (see Appendix).

Teacher growth mindset (TGM)

In order to reduce the likelihood of desirable responding, teachers were first provided with a brief scenario about a struggling student. The scenario read: "*Imagine that Michelle/Michael [counterbalanced] is a girl/boy in your class who is mostly attentive but struggles to understand main topics and apply them later. Additionally, she/he has been struggling to get passing grades. Based on your experience with and knowledge about children, please answer the following questions. There are no right or wrong answers.*" Teachers next completed three items (see Appendix) used to assess the extent to which teachers believed the student's intelligence to be a fixed trait (Dweck, 1999; Dweck, 2006). Teachers responded to items using a 6-point Likert scale ranging from *Strongly Disagree* to *Strongly Agree*. Items were reverse-coded such that higher scores (i.e., 4 or above) indicated growth mindset and lower scores (i.e., 3 or below) indicated fixed mindset. These items showed acceptable internal consistency at time 1 ($\alpha = 0.69$).

Student and teacher demographics

Students and teachers reported demographic information including gender, grade, and country via surveys administered at time 1 (see Table 1 for univariate statistics and bivariate correlations of all study variables). Student-reported gender and teacher-reported grade and country were used in analyses.

Analytic plan

These data represent students nested in classrooms. As such, the intraclass correlation (ICC; the proportion of variance in the outcome at each level of analysis) from a fully unconditional two-level model was first assessed to determine whether dependency of the data needed to be accounted for. In line with convention, an ICC greater than approximately 0.15 (i.e., 15%) is evidence of dependency and suggests multilevel modeling to be the appropriate analytic approach (Raudenbush & Bryk, 2002). Results showed that 5% of the variation in students' time 2 growth mindset existed between classrooms, indicating no need to account for between-classroom clustering. School-level identifiers were not provided in the dataset, and thus was not examined.

Given our proposition about the associations between TGM and SGM, two regression models were constructed. The first (Model 1) included time 1 TGM and student gender associated with time 2 SGM, holding constant time 1 SGM, teacher gender, country (reference group was USA), and grade-level (reference group was grade 5). The second model (Model 2) was identical to the first but included the interaction between time 1 TGM and student gender.[4] In this model, student gender was included as a moderator, while variables such as grade-level and country of data origin (i.e., Canada vs. USA) were used as covariates. To aid interpretation of the findings, student and teacher growth mindset were standardized ($M = 0$, SD = 1).

All analyses were run in Mplus version 7 using the maximum likelihood estimator with robust standard errors to account for issues of non-normality, and FIML to account for missing data (Enders & Bandalos, 2001). Included in the tables and text are standardized estimates which can be interpreted as effect sizes. Both the Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) are included as measures of comparative fit in which smaller values of each are preferred (Burnham & Anderson, 2004).

Results

On average, students reported moderate levels of growth mindset, which increased from fall ($M = 3.84$, SD = 0.98) to spring ($M = 4.11$, SD = 0.86). This trend was consistent across all grades except grade seven where students reported lower growth mindset in spring ($M = 4.09$, SD = 0.89) than fall ($M = 4.13$, SD = 0.90). Similarly, growth mindset tended to increase from fall to spring for both boys ($M_{Fall} = 3.80$; $SD_{Fall} = 0.99$; $M_{Spring} = 3.97$; $SD_{Spring} = 0.90$) and girls ($M_{Fall} = 3.89$; $SD_{Fall} = 0.96$; $M_{Spring} = 4.24$; $SD_{Spring} = 0.80$), though boys reported slightly lower growth mindset compared to girls at both time points. On average, teachers also reported moderate levels of growth mindset in fall ($M = 4.74$, SD = 0.80). Though teachers used most of the provided options on the response scale (Range = 2–6), the median and mode were identical (4.33) and similar to the mean. This indicates that the mean and standard deviation accurately reflect the data and are not unduly skewed by outlying values. Following are the results for each of our research questions.

[3] Gehlbach and Hough (2018) speculate that the low reliability found for students below grade 7 is due to the negatively worded items. California CORE districts have since transitioned to using a version of the scale with positively worded items. Nonetheless, the negatively worded version of the scale has been used to investigate relations with relevant student outcomes including academic achievement and absences (West, Buckley, et al., 2018).

[4] Given that results might have varied dependent on whether or not students spend the majority of their school day with one teacher or several, a sensitivity analysis was conducted examining whether elementary school status moderated the association between teacher growth mindset and change in students' growth mindset. Results showed that the interaction was not statistically significant, indicating that, at least in this sample, the impact of teacher growth mindset on students' growth mindset did not vary as a function of the time spent with students.

Table 1
Descriptive statistics and bivariate correlations for all study variables excluding grade level.

Variable	1	2	3	4	5	6	7
M	3.84	4.11	4.74	0.92	0.49	0.60	0.40
SD	0.98	0.86	0.80	0.28	0.50	0.49	0.49
Minimum	1	1	2	0	0	0	0
Maximum	5	5	6	1	1	1	1
1. Time 1 student growth mindset	1						
	(1957)						
2. Time 2 student growth mindset	0.32***	1					
	(755)	(755)					
3. Time 1 teacher growth mindset	0.01	0.13***	1				
	(1957)	(755)	(1957)				
4. Teacher female	0.03	0.11**	−0.04	1			
	(1957)	(755)	(1957)	(1957)			
5. Student female	0.05*	16***	−0.01	−0.01	1		
	(1957)	(755)	(1957)	(1957)	(1957)		
6. USA	−0.04	0.06	0.35***	−0.08***	0.01	1	
	(1957)	(755)	(1957)	(1957)	(1957)	(1957)	
7. Canada	0.04	−0.06	−0.35***	0.08***	0.01	−1.00***	1
	(1957)	(755)	(1957)	(1957)	(1957)	(1957)	(1957)

Note. *N* varies due to missing data. *M* = mean; SD = standard deviation; USA = United States of America.
*** $p \leq .001$.
** $p \leq .01$.
* $p \leq .05$.

The association between TGM and SGM

Table 2 reports results from Models 1 and 2.[5] In support of our proposition, TGM was significantly positively associated with increased SGM over the academic year (B = 0.10, $p \leq .01$ INCLUDEPICTURE "C:\\var\\folders\\yl\\8qhrky013mz8vs27l1g8v7lntd2y32\\T\\com.microsoft.Word\\WebArchiveCopyPasteTempFiles\\cidimage002.png@01D4AC0A.3599F680" * MERGEFORMAT). This finding indicates that a one standard deviation increase in TGM was associated with a 10% standard deviation increase in time 2 SGM, holding constant time 1 SGM. Similarly, students' gender was significantly associated with increases in their growth mindset (B = 0.24, $p \leq .001$). On average, female students reported nearly a quarter standard deviation higher growth mindset over the academic year compared to males. Of note, teachers' gender was also significantly positively associated with increased SGM (B = 0.28, $p \leq .05$ INCLUDEPICTURE "C:\\var\\folders\\yl\\8qhrky013mz8vs27l1g8v7lntd2y32\\T\\com.microsoft.Word\\WebArchiveCopyPasteTempFiles\\cidimage002.png@01D4AC0A.3599F680" * MERGEFORMAT). On average, students with female teachers reported a 28% standard deviation increase in growth mindset over the academic year compared to students of male teachers. While the sample was comprised of only 8% male teachers, this is consistent with the general gender breakdown of elementary teachers in the United States (National Center for Education Statistics, 2021). No other covariates were significantly associated with change in SGM.

Table 2
Results from regression models investigating the relationship between teachers' growth mindset (TGM) and students' growth mindset (SGM) over the academic year.

	Model 1		Model 2	
	β	S.E.	β	S.E.
Time 1 SGM	0.28***	(0.04)	0.28***	(0.04)
Time 1 TGM	0.10***	(0.04)	0.16***	(0.06)
Student Female	0.24***	(0.06)	0.27***	(0.07)
Interaction	–	–	−0.12†	(0.07)
Teacher Female	0.28*	(0.12)	0.28*	(0.12)
Canada	−0.06	(0.08)	−0.06	(0.08)
Grade 4	−0.06	(0.09)	−0.07	(0.09)
Grade 6	−0.01	(0.09)	−0.01	(0.09)
Grade 7	−0.04	(0.12)	−0.03	(0.12)
Grade 8	−0.08	(0.18)	−0.08	(0.17)
AIC	12,886.32		12,885.00	
BIC	12,975.59		12,979.85	
R^2	0.14		0.16	

Note. *N* = 1957. Standardized estimates are presented for continuous variables. Standard errors are in parentheses. Full information maximum likelihood (FIML) was used to account for missing data. S.E. = standard error; AIC = Akaike Information Criterion; BIC = Bayesian Information Criterion. USA is the reference country. Grade 5 is the reference grade.
*** $p \leq .001$.
** $p \leq .01$.
* $p \leq .05$.
† $p \leq .10$.

Moderating effect of student gender on the TGM-SGM association

Results from the path model investigating the interaction between TGM and student gender mirrored the trends observed in Model 1 (see Model 2 in Table 2). Additionally, while not statistically significant (β = −0.12, $p = .07$), a trending interaction term emerged, slightly increasing the R^2. Whereas female student mindset was already higher and appears relatively uninfluenced by teachers who reported lower TGM, male students were advantaged by teachers with higher TGM. Put another way, teachers reporting a fixed mindset were associated with a more fixed mindset among male, but not female, students. Thus, the moderator analysis highlights what may be an emergent gender effect: male students may respond positively to teachers with a growth mindset, and development of a growth mindset appears to be hindered when associated with a teacher with low growth (i.e., high fixed) mindset.

Discussion

Findings reveal that teachers with a growth mindset have a statistically significant, and positive, association with the development of their

[5] As a robustness check, we also ran all models using structural equation modeling (SEM), and results did not vary from those assessed with observed as opposed to latent variables. This indicates that the results presented were not sensitive to measurement error introduced by the low reliability on student growth mindset in grades 4 and 5. We thus retained the regression model due to its heightened interpretability.

students' growth mindset over a school year. Thus, our theory is supported and we make a novel contribution to the field in providing empirical data on the association between teacher mindset and student mindset within schools: teacher growth (fixed) mindset is positively (negatively) associated with development of student growth mindset. This main effect on its own is important because it provides preliminary evidence in the mindset domain of the influence that teachers' characteristics may have on their students' development. Additionally, this finding is notable because it suggests that mindset interventions for students, which are abundant in the marketplace, could benefit from incorporating a mindset intervention for teachers as well. Further, where growth mindset development in students is valued, teacher education and professional development might also seek to include a growth mindset development component.

Strengths and limitations

The large, international sample testing an important relationship is a strength of this study. Further, FIML – a method that produces unbiased parameter estimates and is robust to issues of non-normality – was used to retain cases with missing continuous data, ultimately bolstering the present study's sample size. Data from a final sample of 57 teachers and 1957 students in two countries helps us identify that teacher mindset is associated with the development of student mindset over time. Additionally, while evidence on the relationship between growth mindset and achievement is mixed (Schenke et al., 2015; Stipek et al., 2010; Kennett & Keefer, 2006 vs. Burnette et al., 2013; Li & Bates, 2019; Burgoyne et al., 2020), we tentatively propose that this research may have uncovered a factor contributing to the gender gap between failing boys and succeeding girls in schools. It requires empirical investigation whether interventions developed for teacher growth mindset could influence the academic outcomes of male students, and under what conditions. The dataset did not include information on race/ethnicity or language status, resulting in an inability to control for variation in SGM attributable to these demographic characteristics and identifying a topic for needed future research. Student data did come from classrooms across the USA and Canada, however, providing a diverse sample by geography (i.e., urban vs. rural) and socio-ethnic background.

We note that the measurement of SGM in this study yielded acceptable but low alpha values. Although our alpha values were consistent with previous research (Gehlbach & Hough, 2018; West et al., 2018), the measure used was drawn from a measure widely used in the field (West, Buckley, Krachman, & Bookman, 2018), and CFA analysis indicated that the same underlying construct was being measured across all grades, we suggest that there is considerable opportunity to improve the measurement of growth mindset in younger children. For example, prior research has indicated that negatively phrased items perform particularly poorly (Gehlbach & Hough, 2018), and this may be heightened in populations who are not yet reading at grade level. Future research should directly address this important psychometric gap with implications for both research and practice. Relatedly, two sets of sensitivity analyses were conducted: (1) restricting the sample to those observations that had complete data at both time points to ensure results were not driven by FIML and (2) examining SGM and TGM as latent constructs, which has the comparative advantage of excluding measurement error, some of which was likely attributable to low alphas among 4th and 5th grade students (see Appendix). Results did not vary dependent on sample restriction or latent variable modeling, providing further evidence of the robustness of the findings presented in this study.

Importantly, all students and teachers surveyed herein were involved in a SEL intervention, meaning that growth mindset was known and likely salient to teachers throughout the year. While participation in the intervention could not in itself explain either our main effect or interaction effect, it may to some degree influence the generalizability of our findings. However, given the relative ubiquity of SEL programs in public schools of late, it seems unlikely that this would have a substantive effect. Rather, this may have resulted in a conservative test of the effect of TGM, given the likely narrower range of growth mindset scores among teachers who chose to participate in the program, and thus potentially underestimating the magnitude of the observed associations.

Whereas the student sample was relatively gender equal (49:51), the sample of teachers was predominantly female (>90%). Given that this is normative within the profession, it may long be a limitation with which we must contend, despite empirical justification for more male teachers (McGrath & Sinclair, 2013). We also acknowledge that contemporary view of gender identity is that it is not a purely binary construct. Throughout this paper, we use the binary terms of boy/girl, male/female based on students self-identifying as one of these categories, given their options. However, in recognizing the continuum of gender fluidity, we acknowledge that individuals may identify in ways not offered in this survey and acknowledge this as a weakness in the study. We encourage future research to construct gender categories that are better representative of all.

Finally, we recognize that the literature on the role of growth mindset in education broadly, and student achievement specifically, is evolving. For example, whereas some research suggests there is a strong relationship between implicit theories of intelligence and student achievement (e.g., Rattan et al., 2015), including suggesting that mindset interventions can heighten student achievement (e.g., Yeager et al., 2019), others have observed relationships contravening mindset theory (Burgoyne et al., 2020) with classic studies failing to replicate (Li & Bates, 2019) and indicating that mindset effects may not hold for all students (i.e., those not in a low SES context or not at-risk for low academic achievement; Sisk et al., 2018). We suggest that the findings herein contribute to continued expansion of the mindset literature.

Future research

We suggest that the work herein contributes to the literature by providing initial evidence on which many interesting research questions can be developed and tested. Although we provide evidence of a theorized main effect of teacher growth mindset on student growth mindset development, our emergent evidence of gender moderation merits further investigation. Given that the effect size of student gender related to change in SGM was largest of all significant predictors, including baseline SGM, and that the slope for girls was not steep, there is a need for research to better understand what is contributing to the girls' SGM increasing over the year at a higher rate than the boys'. Namely, why might such an association, if it exists, occur? As previously outlined, one reason may be the different ways in which students receive feedback from teachers (see de Kraker-Pauw et al., 2017), and the extent to which that feedback conveys meaningful, repetitive, and/or ongoing evidence of a teacher's true beliefs concerning a student's abilities. For example, boys are shown to have poorer inhibitory control and higher incidence of externalizing than girls (Else-Quest et al., 2006), and thus may receive more direct correction (Bertrand & Pan, 2013) and criticism from teachers (Dweck et al., 1978). This alone could account for any observed differences over time, wherein boys may receive more evidence of their teacher's true beliefs about their abilities than do girls. Further, while girls are more likely to receive comfort-oriented feedback, which has been shown to decrease motivation (Rattan et al., 2012), such feedback may over time nonetheless insulate female students better against buying into their teacher's mindset than males'. Future research should confirm this result and dive deeper into the mechanism behind the associations observed herein. Certainly, identifying and investigating causal mechanisms will only create more options for intervention that will ultimately better prepare students for success.

Thus, the next steps are clear: augmentation with causal evidence of

the relationship between TGM and SGM, and exploration of the mechanisms through which it transpires, including how this mechanism may vary by student gender and other classroom and sociodemographic factors.[6] For example, might the association between teacher and student growth mindsets be enhanced (attenuated) in subjects in which gendered (no gendered) norms exist (e.g., mathematics for girls vs. reading and writing for boys)? Further, what role might classroom composition play in the association between teacher and student growth mindset? For example, students who are in the ethnic (or gender) minority might be particularly susceptible to influence by a teacher's mindset, in contrast to their majority-group peers. Additionally, but relatedly, might student and/or teacher race or nationality moderate these effects (see Canning, Muenks, Green, & Murphy, 2019)? Inquiry into the role of contextual factors in this process may present fruitful opportunities for future research.

Future research must also tease apart when and how teacher mindset is developed, with a particular interest in measuring the effects of TGM intervention and transformation in teacher preparation programs. Equally important will be investigating the effects of TGM interventions in schools to determine whether a change in teachers' mindsets generates positive outcomes for students, as well as examining the extent to which TGM is differentially associated with students' growth mindset as a function of school-level and/or grade level. To our knowledge, this is the first study that looks specifically at the association between TGM and SGM. Our findings herein are an important first step, yet there is still much to be done.

Herein, we focused on the potential conveyance of mindset from teacher to student over time, demonstrating that teachers with a low growth mindset were associated with poorer development of student growth mindset; this was more pronounced among male students. Based on Sisk et al.'s (2018) findings, our study examining students in predominantly low-socioeconomic contexts across the United States and Canada may have met a precondition to observing mindset effects, with our results showing the strongest association for more at-risk students (i.e., males). That is, the low-socioeconomic context may need to be salient for observing mindset effects. As such, our findings may be most readily generalized to similar contexts, and thusly, may be most valuable to those working with students in low socio-economic contexts like those examined here, those focusing on students whose demographics or other experiences place them at-risk, or both. Alternatively, or in addition, this may represent an emergent finding, which could shift if the gender gap in education continues to widen. Future research should seek to replicate and extend these findings to determine whether context enhanced or inhibited the magnitude of effects identified herein.

Conclusions

Our research identifies, and presents initial evidence to address, a gap in our understanding of the development of mindset in students. In particular, this study leveraged the intra-individual theory of motivation (Dweck & Leggett, 1988) coupled with DST (Pianta et al., 2003) and EST (Bronfenbrenner, 1979; Woodside et al., 2006) to identify a positive association between teacher growth mindset and development of student growth mindset over time. This provides preliminary evidence that characteristics of teachers – particularly the degree of their own growth versus fixed mindset – may shape students' development. Further, we found some evidence that this association may be most pronounced among male students, with teacher fixed mindset predictive of more fixed mindset development. As boys may be increasingly at risk of diminished academic achievement (Autor & Wasserman, 2013; Murnane, Singer, Kemple, & Olsen, 2009), our findings provide fruitful avenues for further inquiry. Taken together, the current work provides important initial evidence and future directions for research and practice in an under-developed area of study.

Declaration of Competing Interest

None.

Appendix A. Appendix

Table A1
Complete list of student growth mindset scale items.

My intelligence is something that I can't change very much
There are some things that I am not capable of learning
Challenging myself won't make me any smarter
If I am not naturally smart in a subject I will never do well in it

Table A2
Complete list of teacher growth mindset scale items.

The student may get better grades, but won't be able to change their academic ability
The student will probably advance to the next grade, but assessment scores and ability in school will not differ much
This student's difficulties in understanding the main topic will make it difficult for the student to improve their base academic ability

Table A3
Sample size and alpha by grade level and time period.

	Fall		Spring	
	N	Alpha	N	Alpha
Grade 4	253	0.62	182	0.62

(*continued on next page*)

[6] We thank one of our anonymous reviewers for explicating several of the suggestions in this section.

Table A3 (*continued*)

	Fall		Spring	
	N	Alpha	N	Alpha
Grade 5	814	0.68	188	0.57
Grade 6	521	0.70	263	0.75
Grade 7	189	0.73	87	0.78
Grade 8	180	0.75	34	0.84
Average		0.70		0.71

Table A4
Results from structural equation models investigating the relationship between teachers' latent growth mindset (TGM) and students' latent growth mindset (SGM) over the academic year.

	Model 1		Model 2	
	β	S.E.	β	S.E.
Time 1 SGM	0.45***	(0.06)	0.45***	(0.06)
Time 1 TGM	0.12**	(0.05)	0.20**	(0.07)
Student Female	0.17***	(0.04)	0.19***	(0.04)
Interaction	–	–	−0.11†	(0.06)
Teacher Female	0.10*	(0.05)	0.10*	(0.05)
Canada	−0.04	(0.05)	−0.04	(0.05)
Grade 4	−0.03	(0.04)	−0.04	(0.04)
Grade 6	−0.03	(0.05)	−0.03	(0.05)
Grade 7	−0.02	(0.05)	−0.02	(0.05)
Grade 8	−0.02	(0.07)	−0.02	(0.07)
AIC	34,706.20		34,704.82	
BIC	34,890.31		34,894.52	
TLI	0.93		0.94	
CFI	0.95		0.95	
RMSEA	0.03		0.02	
SRMR	0.04		0.03	

Note. $N = 755$ Standardized estimates are presented. Standard errors are in parentheses. Student and teacher growth mindset are modeled as latent variables. Full information maximum likelihood (FIML) was used to account for missing data. S.E. = standard error; AIC = Akaike Information Criterion; BIC = Bayesian Information Criterion. USA is the reference country. Grade 5 is the referent grade.

*** $p \leq .001$.
** $p \leq .01$.
* $p \leq .05$.
† $p \leq .10$.

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